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THE NEWER APPALACHIANS OF THE SOUTH

PART II. SOUTH OF THE NEW RIVER

FRANK J. WRIGHT

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Advance Summary

This essay is a regional geomorphic study of the southern part of the Newer Appalachians of the South. Interpretations of a general nature were treated at length in earlier papers but here they are presented in brief form and only as they relate directly to this particular region.

Field evidence is insufficient for the recognition in this area of a peneplane older than the Schooley. Even the Schooley has been so extensively dissected that its restoration on the basis of preserved remnants is tentative. Most of the features of the topography date from the Harrisburg and post-Harrisburg cycles. Although it is difficult to determine its exact elevation at any given point, the Harrisburg peneplane is represented in many localities throughout the Appalachian Valley. It has an elevation of approximately 600 feet at the southern end of the province and 2600 feet on the New-Holston divide. Since its surface rises upstream regardless of the direction of stream flow, the peneplane slope is regarded as largely original, rather than as due to warping as explained by Campbell (18).

Post-Harrisburg time may have been broken into several cycles

or partial cycles by successive uplifts. While keeping a hospitable mind toward this possibility, the evidence thus far examined does not point convincingly in this direction. The most impressive product of post-Harrisburg erosion is a series of lowlands called the "Coosa Peneplain" by Hayes, and "Coosa lowlands" by the present writer. In this paper an alternative explanation on the basis of solution and corrasion in the present cycle is advanced. The dominance of subsequent drainage and the mildness of the climate are factors in the development of these lowlands.

Introduction

General

This paper is the third in a series by the same author. The first, entitled "The Older Appalachians of the South" (73), was published in 1931. It was followed in 1934 by "The Newer Appalachians of the South (Part I)" (74). The main purpose running through all of them is to treat briefly the events in the history of the Older and Newer Appalachians[1] that have left

[1] The terms Older and Newer Appalachians are used in this paper in their usual sense to denote two large, sharply contrasted Appalachian provinces, the rocks of which for the most part differ from each other in age. The terms are not satisfactory to the Publications Committee of the Geological Society of America and not entirely satisfactory to the present writer. The Publications Committee objects to the use of these terms as province names on the ground that Newer and Older have no reference to the relative ages of the provinces, but are concerned with the ages of the rocks involved. "Appalachian Valley and Ridges" is employed by members of the U. S. Geological Survey and others for the province which is here called the Newer Appalachians.

To make clear to the reader the usage of province names as employed in this paper, the following definitions are given:

"Appalachian Highlands" includes the entire Appalachian region from the Coastal Plain on the east to the Interior Lowland on the west. "The Appalachians" will not ordinarily be used, but may be employed as an abbreviation for "Appalachian Highlands," where the meaning is clear. In like manner, "Northern Appalachians" and "Southern Appalachians" are convenient abbreviations for Northern Appalachian Highlands and Southern Appalachian Highlands. The

clearly recognizable traces in the present topography. Areas where the topographic features produced in the several cycles are typically represented are described in some detail, and special local problems, such as stream piracies, are attacked in the light of regional history. It is believed that regional geomorphic studies covering large areas have value in that they tend to unify and correlate local interpretations and minimize the importance of local variations from the general history.

The Schooley and Harrisburg cycles of erosion were recognized and their peneplane surfaces described in the paper on the Older Appalachians. The possibility of the existence of a later peneplane, the Somerville, was considered, but the writer did not find sufficient field evidence to justify its definite inclusion. The oft-discussed problem of the origin of the Blue Ridge escarpment, as well as the drainage changes that have taken place at many points along the Atlantic-Gulf divide, were studied. A number of small, high-lying, even-surfaced basins in the Older Appalachian Mountains have remarkably similar characteristics, but they are drained by different streams and stand at elevations ranging from 2200 feet to more than 3500 feet. Their interstream areas are notably even and slope downstream. The Asheville basin is probably the most typical and the best known. They have usually been assigned to different erosion cycles. The writer interpreted them as parts of the Harrisburg erosion record, and correlated them with the regionally developed Harrisburg peneplane of the Appalachian Valley, and also tentatively with the Piedmont peneplane.

In Part I of "The Newer Appalachians of the South" the evi-

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writer uses the Potomac River as the dividing line between the Northern and Southern Appalachians.

The Newer Appalachians are divided into two parts, each with province rank. The eastern division is called the "Appalachian Valley," and the western the "Appalachian Ridges." "Valley" is occasionally used for "Appalachian Valley" to avoid needless repetition where the meaning is obvious; in like manner, the term "Ridges" refers to "Appalachian Ridges."

"Appalachian Plateau" is used in its usual sense to include the area of essentially horizontal sedimentary rocks west of the folded mountains. Its eastern margin is in many places a bold escarpment known as the "Allegheny Front."

dence for a pre-Schooley cycle and peneplane was reviewed. While he did not deny the existence of a peneplane older than the Schooley, the writer did not feel sufficiently sure of its recognition in the field to justify its inclusion. The Schooley cycle left its record in the Schooley peneplane. Harrisburg erosion was undoubtedly responsible for a large number of the topographic features of the region and its record can be traced from broad, moderately even remnants in the Appalachian Valley up the narrower valleys at increasing elevations until at their heads the streams are flowing practically at their Harrisburg levels. Post-Harrisburg erosion has produced stream terraces, but no surface at a consistently uniform elevation above the present streams such as to convince the writer of the necessity of introducing into this outline a cycle or partial cycle, like the Somerville, to account for all of the major elements in the topography. Two local problems of interest because of the use of principles deduced from the study of the nature of Harrisburg erosion in their attempted solutions are the piracy of tributaries of the New River by the Roanoke River (by which an area of approximately two hundred square miles was abstracted from the New River), and the origin of Natural Bridge. The writer concluded that the correct explanation of the origin of Natural Bridge must ultimately be found in an accurate interpretation of the regional drainage history of the surrounding area. A stream piracy, caused largely by the development of limestone sink drainage and its concentration in an underground channel leading from a higher to a lower level, was apparently a major factor in the origin of the Natural Bridge and its associated features.

Field work on Part II was undertaken during the summers of 1934 and 1935, and extended southward to the northern margin of the Coastal Plain overlap south of Birmingham, Alabama. This makes it possible to include an account of the southern end of the province and thus to cover in a general way its entire extent between the Potomac River and central Alabama.

ACKNOWLEDGMENTS

It is with deep gratitude that the writer acknowledges the receipt of a grant from the Penrose Bequest of the Geological

Society of America. It has been used to defray field expenses and to provide illustrations for this paper. In 1934 Professor Douglas Johnson spent three days with the author in going over the Natural Bridge area and the Roanoke River piracy problem, both of which had previously been treated in Part I. His criticisms and suggestions have been helpful in preparing this manuscript. Dr. Charles R. L. Oder spent a day in the field with the writer. He also read a large part of the manuscript and offered many helpful suggestions. The following Denison geology assistants have rendered aid in the field and office: Virginia Smith, Gibson Dildine, Matthew Mawhinney, Glenna Snapp, Catherine Ball, Phyllis Howard, Lauren Conger, and William Lewis.

BOUNDARIES AND SUBDIVISIONS

The boundaries of the Newer Appalachians of the South are, for the most part, clearly defined (Fig. 1). The massive, high mountains of the Older Appalachians extend on the southeast from Roanoke, Virginia, to northern Georgia. The Iron, Unaka, Bald, Great Smoky, and Cohutta Mountains form an almost continuous range from northeast to southwest, except where broken by the gaps of streams flowing from the highlands beyond. In northern Georgia the Cohuttas disappear, and the Appalachian Valley comes in direct contact with the Piedmont. Surmounting the Piedmont in this region are a number of prominent monadnock masses, such as Pine Log Mountain a few miles northeast of Cartersville, Georgia. The Piedmont stands several hundred feet above the floor of the Appalachian Valley, and its western border is in many places a sharply defined escarpment. In the vicinity of Anniston, Alabama, however, there is a long, narrow subsequent valley between the main Piedmont on the east, and the rugged Choccolocco Mountain, underlain by Cambrian quartzite, to the west. Farther south the Piedmont surface becomes lower and lower until it has about the same elevation as the Appalachian Valley where the two provinces pass under the Coastal Plain.

The southern boundary is difficult to draw on the basis of topography. The Appalachian provinces descend gently under the Coastal Plain sediments, small outliers of which indicate a

former northward extension of the Coastal Plain. By referring to the map (Fig. 1) the reader will note the approximate position of this boundary line.

The Newer Appalachians are bordered on the west by the Appalachian Plateau. Within the limits of the area under consideration, there are several different types of expression of the

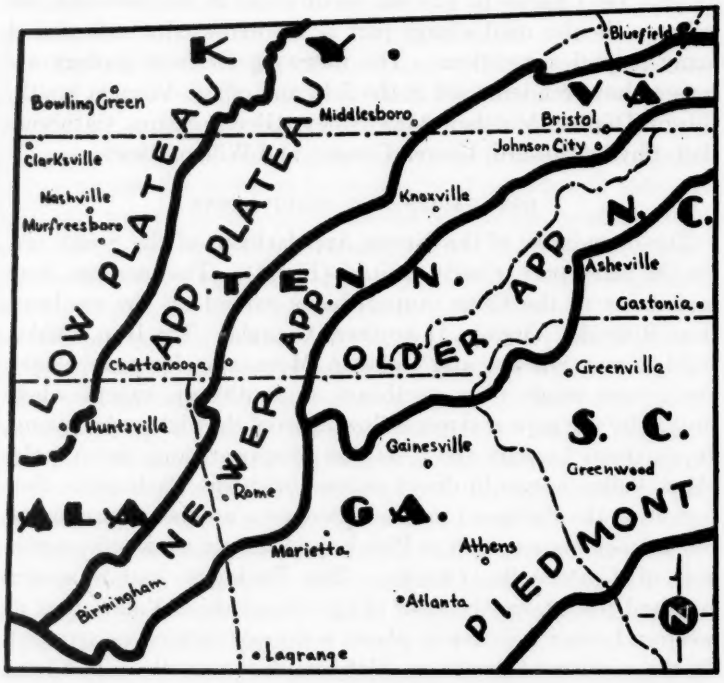


FIG. 1

eastern border of the Plateau. At the extreme southern end it is a low escarpment in which the dip of the rocks varies from a very low angle up to possibly fifty or sixty degrees, as, for instance, west of Bessemer, Alabama. Although belts of Carboniferous rocks lie to the east of this escarpment, they are considered as a part of the Newer Appalachians province. A short distance

north of Birmingham, the escarpment forming the eastern border of the Plateau becomes higher and more prominent.

Long, narrow strips of Plateau, separated from the main part of the province by deep subsequent valleys, characterize the eastern margin of the Plateau province from Gadsden, Alabama, to central Tennessee (*Plate XXVII*). Sand and Lookout Mountains, south of Chattanooga, Tennessee, and Walden Ridge to the north, are the most prominent of these features; they form the Cumberland Escarpment. Cumberland Mountain, the southeastern edge of a great thrust block extending north from Briceville Tennessee, to and beyond Cumberland Gap, is another type of plateau border.

The Newer Appalachians are divided into two provinces, the Appalachian Valley on the southeast and the Appalachian Ridges on the northwest. The Appalachian Valley extends from New York to central Alabama. It is underlain by limestone and shale, with local exposures of sandstone. Its surface is a gradually rising peneplane beginning with an altitude of about 600 feet south of Birmingham and attaining a height of 2600 feet on the New-Holston divide, a short distance southwest of Wytheville, Virginia. The evenness of its surface is broken by many low ridges and hills, most of which trend with the strike. They are underlain by cherty limestone, sandy shale, or sandstone.

The Appalachian Ridges province is variable in width and in the number of its component ridges. Northwest of Marion, Virginia, the belt of ridges is twenty miles wide and consists of a series of prominent parallel ridges such as Clinch and Walker Mountains, separated by narrow intermontane valleys. In the latitude of Knoxville, Tennessee, there are no typical Appalachian ridges, and the entire area between the Great Smoky Mountains on the southeast and the Cumberland Escarpment on the northwest is really a typical part of the Appalachian Valley province, with a width of nearly forty miles.

DIFFERENCES BETWEEN THE NORTHERN AND SOUTHERN DIVISIONS

While the dividing line between the northern and southern parts of the Newer Appalachians of the South is arbitrarily drawn

for the sake of convenience, on the divide between the New and Holston (tributary of the Tennessee) Rivers, there are some noteworthy differences in the geomorphic features of these two regions. In the first place, the belt of Appalachian Ridges narrows toward the south and disappears entirely in eastern Tennessee. Ridges appear again in the Birmingham region. Furthermore, the individual ridges are higher, more massive, and more numerous in the northern section than in the southern. As the ridges becomes less prominent toward the south the Valley becomes correspondingly wider.

There is much variety in the structural types of the ridges in the central Virginia portion of the Appalachian Ridges where typical anticlinal, monoclinal, and synclinal ridges and valleys are found in various successions. Great thrust faults have complicated the structure in the southern area and very few typical anticlinal and synclinal ridges are found there. The structure is mostly monoclinal, or homoclinal, due to the enormous thrusts from the southeast, giving regional dips in that direction. Clinch Mountain, the most persistent and prominent unit in the Appalachian Ridges of southwestern Virginia and eastern Tennessee, is an example of this type of structure.

North of the Tennessee and Holston Rivers, all of the master streams leave the Appalachian Valley through gaps either in the Older Appalachians to the southeast or in the Ridges to the northwest. From the New-Holston divide south to the gorge of the Tennessee River west of Chattanooga and from this point to the southern end of the province, the main drainage lines and many of the tributaries are subsequent. No major drainage changes have taken place since the close of the Harrisburg cycle and hence the same conditions obtained in that cycle. Strong subsequent streams such as the Powell, Clinch, Holston, French Broad, and Tennessee Rivers developed the Harrisburg peneplane in this region. Although rocks of low resistance throughout the Appalachians were eroded down to levels appropriate to their location during that cycle, it is obvious that the peneplane, theoretically at least, would have been best developed in an area drained by such closely-spaced and powerful subsequent streams. Carry-

ing the point still further, it would mean that in post-Harrisburg time the Harrisburg peneplane in such a region would be most thoroughly dissected.

In all parts of the Appalachian Valley and in some of the valleys of the Appalachian Ridges the limestones have been greatly affected by solution. Limestone caverns, numerous sinks, as well as the Natural Bridge and Natural Tunnel of Virginia are due largely to this process. In the southern section the mean annual temperature is higher than in the northern, and the winters are shorter. These factors promote the chemical work of surface and underground water. Broad, flat-floored limestone lowlands characterize to a marked degree the area south of Knoxville, Tennessee. Similar features, but on a much smaller scale, are found in Virginia and in the northern part of the Valley of East Tennessee. Some of these typical lowlands near the southern end of the province are described in a later section of this paper.

Erosional History

The principal part of the present study has to do with the Harrisburg and post-Harrisburg cycles of erosion, and with problems related to those cycles. Nevertheless it may be desirable to review briefly the entire erosional record from the earliest known cycles to the present time.

PRE-SCHOOLEY EROSIONAL HISTORY

In Part I of this essay the writer reviewed the work of Stose (64) and others who have found traces of at least one peneplane that is older and higher than the Schooley. There are topographic features in the northern part of the Southern Appalachians which rise appreciably above the Schooley peneplane. It has not yet been definitely determined whether they should be interpreted as parts of a peneplane or merely as monadnocks on

the Schooley surface. All are agreed that there must have been a cycle or cycles earlier than the Schooley, but some are not yet convinced that a peneplane produced during such a cycle can be satisfactorily restored in the Newer Appalachians of the South.

In the southern section of this province there are really no significant traces of an erosion surface older than the Schooley, because there is little surface above the Schooley level. A few local points such as parts of Clinch and Walker Mountains, northwest of Wytheville, Virginia, rise higher than the Schooley peneplane is supposed to stand, but their nature and distribution are such as to lead to their interpretation as Schooley monadnocks rather than as remnants of a peneplane. If one goes to the bordering mountains on the southeast, he finds fairly even skylines which are higher than the supposed level of the Schooley. This is particularly true in the Great Smoky Mountains of eastern Tennessee and western North Carolina, where a fairly even skyline is preserved at an elevation of nearly 6000 feet. This was mentioned by Willis (70) in his illuminating essay entitled "Round About Asheville," and described by the present author in his "Older Appalachians of the South" (73).

THE SCHOOLEY CYCLE

The Schooley peneplane is widely recognized in many parts of the northern and southern Appalachians. By reason of the fact that the Appalachian ridges south of the New River are less numerous and less uniform in elevation, it is difficult to restore the peneplane in this area. Since there are no features in the Appalachian Valley which rise to the height of the peneplane level, it is obvious that its restoration south of the New River must rest upon rather slender evidence.

In the following paragraphs a few localities where the Schooley seems to be preserved will be described, but it is impossible at present for the writer to point to any single locality where the Schooley can be identified with absolute certainty. It is very obvious, however, that some of the most conspicuous features of the present topography date from the Schooley cycle, and it is for this reason that the author ventures to point out some of the

most typical of these, and to indicate some of the problems involved in the restoration of the Schooley peneplane. Profiles and map studies, in addition to field work, have been used in attacking this problem.

As one goes south from Bluefield, West Virginia, on the northern border of the Appalachian Ridges, to Wytheville, Virginia, in the Appalachian Valley, he traverses a series of parallel ridges, the most prominent of which are East River, Buckhorn, and Rich Mountains. From the crest of East River Mountain there is an excellent view of Buckhorn and Rich Mountains, the latter maintaining a very even skyline at an altitude of nearly 3500 feet, as may be seen in *Plate XXVIII*. Rich Mountain seems to mark a peneplane level, and since this elevation corresponds rather closely to that of the Schooley surface a few miles to the northeast, it seems logical to interpret Rich Mountain as a remnant of the Schooley peneplane. One difficulty in this interpretation lies in the fact that the Appalachian Plateau, less than a dozen miles to the north, has a moderately even surface at an altitude of approximately 3000 feet. This anomaly may be explained on the basis of difference in structure, whereby the upturned edges of resistant rocks would probably stand higher than areas of horizontal structure which are not capped by equally resistant rock. As seen in *Plate XXVIII*, Buckhorn Mountain is considerably lower than Rich Mountain, while in the distance an irregular ridge rises a little higher than Rich Mountain. This is a typical situation in the Appalachian Ridges, where even skylines alternate with ridge crests that are less even, and also higher or lower.

From the floor of the Appalachian Valley at Rural Retreat near Wytheville, Virginia, there is a splendid view of Walker Mountain, the first ridge northwest of the Appalachian Valley. This ridge, like Rich Mountain, has an even crest at an altitude of about 3500 feet. *Plate XXIX* shows a view of this mountain looking northward across the village of Rural Retreat, around which the Harrisburg peneplane is splendidly developed at an altitude of approximately 2600 feet.

From the Pinnacle on Cumberland Mountain (Kentucky-Virginia), there is an impressive view to the southeast across the

low-lying Powell Valley, with higher hills beyond, to a very even skyline formed by the Appalachian Ridges, as shown in *Plate XXX*. Powell Mountain, 2100 feet in elevation, forms the skyline on the left side, while Clinch Mountain, at a little greater distance, forms the skyline on the right. Clinch Mountain varies in elevation from 2100 to 2500 feet. This composite skyline is believed to represent approximately the Schooley level. Cumberland Mountain near Cumberland Gap is 2500 feet in height and continues at this elevation for a considerable distance toward the southwest. Clinch Mountain is the longest and perhaps the most typical of the Appalachian ridges in the southern part of the province.

The even skylines of Walden Ridge and Sand Mountain, outliers of the Appalachian Plateau, at elevations ranging from 1500 to 2000 feet, represent the Schooley peneplane in so far as present determinations have gone. The Cumberland Escarpment is particularly even just west of Canoe Creek Valley in the vicinity of Ashville, Alabama, as shown in *Plate XXXI*. Its elevation here is approximately 1500 feet, and it appears to be a typical remnant of the Schooley surface. Southwest of this point the Escarpment, represented by Sand Mountain, becomes much lower until in the Birmingham region it has almost the elevation of the Harrisburg peneplane. It is indeed not clear to the writer whether any Schooley surface remains in the Plateau west of Birmingham.

Hayes (37) uses the term "Cumberland Peneplain" for the erosion surface described in the preceding paragraphs. Thus he says:

> "In the plateau division the altitude of the reconstructed plain at the southern edge of the district is about 1,200 feet above sea level. From this it increases gradually to a maximum of 2,000 feet along a line crossing the plateau from Sewanee N. 60°E. This increase in altitude gives the plain a grade of about 10 feet to the mile.
>
> To the north of this axis of maximum elevation, and west of the Sequatchie anticline, its altitude decreases slightly, to 1,800 feet at the edge of the district, while east of the anticline the descent is more rapid, reaching 1,600 feet near the Emory River. On the eastern side of the valley there is a similar increase in altitude from 1,200 feet, at the southern edge of the district, to about 1,700 feet near the Hiwassee River. The plain also shows a descent of about 200 feet from

a meridian through the center of the district to its eastern edge. It is thus seen that if the plain has been properly reconstructed the warping has produced an irregular dome-shaped elevation, whose apex is a little north and west of the center of the district."

It is obvious that the Schooley peneplane, as here tentatively restored, varies greatly in elevation. From an altitude of about 3500 feet north of Wytheville, Virginia, it slopes down to approximately 1000 feet a short distance north of Birmingham, Alabama. From this point south to the Coastal Plain overlap the Schooley seems to be absent. This descent of 2500 feet to the southwest in a distance of four hundred miles may be explained as original or due to differential uplift, or to both. Hayes emphasized warping as the prime cause of these differences in elevation. It is now known that the Schooley surface does slope in the direction of the major streams (66), and this would indicate the likelihood of a southwesterly direction for the original downstream slope of the Schooley peneplane in this area. A slope of more than six feet per mile is perhaps too steep to be explained as entirely original in the case of the rather perfectly developed Schooley peneplane. From studies in other parts of the Appalachians the writer (72) concluded that the Schooley was warped during uplift, and he would interpret the southwesterly slope within the area of this study as being the result of an accentuation of the original slope by upwarping at the close of the Schooley cycle. Warping at the close of the Harrisburg was probably not significant.

THE HARRISBURG CYCLE

During the Harrisburg cycle many of the topographic features of the Appalachian Valley and Appalachian Ridges were produced. At its beginning there were exposed at the surface, as the result of earlier peneplanation, numerous northeast-southwest trending strips of country of variable width, underlain by relatively weak limestones and shales. These weak rock belts were followed by subsequent streams, which, as we have already seen, include many of the master streams of these provinces. Separating the weak belts were narrower belts underlain by rocks of

greater resistance ranging from sandy shale and cherty limestone to compact sandstones and quartzites. During this cycle the streams reduced the soft rock belts to lowlands of faint relief. In many of these belts there were layers of cherty limestone which were probably never quite reduced to the level of their surroundings, but remained as slight ridges on the late mature surface produced during the Harrisburg cycle. Belts of sandstone remained as low ridges on the Harrisburg surface, and today constitute linear monadnocks like Bays Mountain.

The areas underlain by the more resistant sandstones and quartzites were but slightly lowered by Harrisburg erosion. Some of them remain as remnants of the Schooley peneplane, as noted in the previous section, while others rise even a little higher than the Schooley where there was a broad exposure of quartzite, as at the northern end of Clinch Mountain. Between the Schooley and the Harrisburg levels there are ridges of diverse elevations which were too resistant to be reduced to the Harrisburg level.

Some of the limestone valleys in the Appalachian Ridges have been reduced considerably below the Schooley level, but apparently not as low as the Harrisburg. This is true in the southern part of the Tazewell, Virginia-West Virginia, quadrangle. The hilltops seem to be fairly accordant in places, but in a valley whose width is not more than a mile or two there could not be much discordance in elevation in areas of uniform rocks, regardless of the presence or absence of an erosion surface. The writer is not inclined to interpret them in terms of any cycle.

The Harrisburg peneplane is practically coextensive with the belts of limestones and shales. From the broad belt of limestone and shale in the main part of the Appalachian Valley, the Harrisburg surface can be traced up the narrower valleys in the Appalachian Ridges at increasing elevations. The peneplane surface rises upstream in all of the drainage basins. So far as the writer is aware, this is universally true in the Southern Appalachians except where post-Harrisburg piracy has occurred. It also normally rises laterally toward the sides of the basin. The Harrisburg surface has an elevation of about 600 feet south of

Birmingham, and rises to about 2600 feet on the New-Holston divide. Its rate of ascent, however, is not uniform. In fact, it descends slightly to the north toward Chattanooga from the divide between the Coosa and Tennessee Rivers. This is in exact agreement with the general nature of Harrisburg surfaces. From Chattanooga northward it rises steadily to the divide at the head of the Holston River.

It is a little easier to restore the Harrisburg peneplane than the Schooley. The possible range of error is less, and the remnants are much more extensive. Nevertheless, it is impossible to be precise when giving the elevation of the Harrisburg peneplane in different areas. There are several reasons why this is true. In the first place, numerous cherty members of the limestone formations formed low residuals or monadnocks on the Harrisburg surface when the cycle came to an end. Coupled with this fact is the occurrence alongside the chert ridges of limestones of relatively high purity which have been greatly affected by solution since the close of the Harrisburg cycle. Furthermore, as already indicated, powerful subsequent drainage has vigorously eroded the region since the uplift of the Harrisburg peneplane. As a result of the operation of these agencies, some cherty ridges and sandy shale areas are a little higher than the Harrisburg peneplane, and some limestone and shale lowlands are more or less below the Harrisburg. In determining the elevation of the Harrisburg peneplane in a given locality, the writer is guided by several conditions. He would regard interstream areas underlain by shale of moderate resistance as more likely to preserve the Harrisburg level than areas underlain by limestone, because the latter have normally been appreciably lowered by solution. In the next place, it seems wise to place the level of the Harrisburg lower than the more prominent of the low, cherty ridges, and always above the level of the limestone lowlands such as are extensively developed around Chattanooga. Projected profiles covering belts of country two miles in width and running consecutively furnish reasonably dependable figures against which to check field observations in determining the elevation of the peneplane.

Because of its pronounced upstream ascent, and the further fact that in many parts of the Newer Appalachians of the South the strips of erosion surface produced during the cycle were very narrow, the question may well be asked whether the Harrisburg should really be called a peneplane. Only in its broader expanses would it meet the specifications proposed by Davis in his early essays on the peneplane.

Monadnocks on the Harrisburg Peneplane

Bays Mountain is a long, linear ridge extending from Kingsport, Tennessee, to a point near Knoxville, Tennessee. It is not quite continuous throughout its course, and is offset several miles just east of Morristown, Tennessee. It has an elevation at the southern end of about 1300 feet and rises to 2200 feet at its northern end. It stands so little above its surroundings in the southern part that it is by no means a conspicuous feature, but the northern portion is wider and more prominent, and splits the Appalachian Valley into two distinct divisions. This ridge is in general synclinal in structure, and capped by sandstone. Its geology has been described by Willis (69). Bays Mountain is a splendid example of a rather prominent monadnock on the Harrisburg peneplane, as may be seen in *Plate XXXII*.

Missionary Ridge, rising 300 to 400 feet above the lowlands to the east and west, is a pronounced feature just east of Chattanooga, Tennessee. This ridge had a strategic position during the military engagements of the war between the States. In *Plate XXXIII* it appears as a wooded feature in the distant middle ground. The position of this ridge crest with reference to the Harrisburg, or any other peneplane level, is not entirely clear. This and other ridges in this region, however, do not make up a large part of the present surface, and in fact stand a little above the areas where the Harrisburg is regionally developed. The writer would interpret these linear, chert-covered ridges as very low monadnocks on the Harrisburg peneplane, and their present prominence as largely due to post-Harrisburg erosion of the bordering limestones. They probably rose 100 feet or more above the original peneplane, which as now restored in the

Chattanooga region stands at an elevation slightly above 800 feet. The broad lowlands on both sides are the result of post-Harrisburg dissection.

The surface of Missionary Ridge is composed almost entirely of chert (*Plate XXXIV*). Limestone appears on the west slope of the ridge from 75 to 100 feet below the crest, but so far as the writer was able to discover, no bed rock appears along the crest, which is blanketed by a heavy residual layer of chert. The angular fragments vary in size from small pieces up to blocks several feet across. This material is so intimately admixed with clay, and so extremely compact, that it forms a hardpan a short distance below the surface which is almost as difficult to excavate as bed rock.

In many parts of the Appalachian Valley there are linear elements which give a distinct grain to the topography. Some of them rise fifty or more feet above the general level, and constitute low monadnocks on the Harrisburg peneplane (*Plate XXXV*), while others are so near the peneplane level that they may be regarded as parts of the erosion surface itself (*Plate XXXVI*).

Typical Harrisburg Areas

In the following pages some of the areas in the southern part of the Appalachian Valley where the Harrisburg peneplane is typically preserved are briefly described. It is hoped that the reader will gain a fairly clear impression of the nature of this surface and its relation to the surrounding features. Photographs help more than verbal descriptions in reaching this objective and consequently a generous number of illustrations is inserted at this point.

There is a very even section of the Appalachian Valley floor on the New-Holston divide near the village of Rural Retreat, Virginia, southwest of Wytheville, Virginia, with an elevation of approximately 2600 feet (*Plate XXIX*). Walker Mountain, a possible Schooley remnant, is seen in the background, the two levels being sharply defined. Another equally typical portion of the Harrisburg surface is shown in *Plate XXXVII*. This view looks south from the floor of the Appalachian Valley and shows

in the background the foothills of the Older Appalachians. These two views taken together portray not only the Harrisburg peneplane at its highest elevation in the Appalachian Valley, but also its relations to bordering mountains to the northwest and southeast.

A short distance southwest of the above-mentioned locality, the Harrisburg surface is developed on shale, locally more dissected than the limestone, which contrasts with the areas on limestone previously described.

In the intermontane valleys of the Appalachian Ridges some limestone areas were broad enough to permit the development of a local peneplane during the Harrisburg cycle. These strips of erosion surface are bordered by rimming mountains, and in some places they are strongly dissected (*Plate XXXVIII*). In other localities the valleys were narrower, so that a local development of the Harrisburg surface would be quickly destroyed in post-Harrisburg time. This condition is portrayed in *Plate XXXIX*, where the graceful lower slopes of the ridges show scarcely a trace of a former even surface. In other parts in the Appalachian Ridges province, there are areas which have been greatly dissected since the Schooley cycle but still stand higher than the Harrisburg peneplane. To attempt to classify such topographic features in terms of cycles seems to be almost hopeless.

The rolling topography of the dissected Harrisburg peneplane in southwestern Virginia is nationally known as a grazing region which annually produces many fancy cattle. A view of this blue grass country is shown in *Plate XL*.

Passing southwest to Tennessee the Harrisburg surface is preserved at an elevation of about 1600 feet. It is shown in *Plate XLI*, where it is broadly developed on limestone about four miles west of Johnson City, Tennessee.

To the west of Greeneville, Tennessee, on the road to Rodgersville, shale hills with graceful outlines preserve the Harrisburg peneplane at an elevation of approximately 1400 feet. Some shales, because of their relatively low solubility, preserve better than limestone the Harrisburg peneplane level in interstream areas. In cases where the shale is especially resistant it may

stand above the Harrisburg surface. Some of the shale regions are very intricately dissected and represent fine-textured topography. No flat surface remains in such areas, and the entire upland is dissected into a series of knobs. One of the most typical of these localities is located on the southeastern side of the Appalachian Valley a short distance southeast of Morristown, Tennessee, and is locally known as The Knobs. It lies between the Nolichucky and French Broad Rivers and preserves the Harrisburg surface at an elevation of approximately 1300 feet. A photograph showing two knobs is reproduced in *Plate XLII*.

Southeast of the Tennessee River at Knoxville, Tennessee, there is a moderately dissected region with accordant interstream areas at an elevation of about 1100 feet. Above the Harrisburg peneplane rise low monadnocks and also a long monadnock ridge, Bays Mountain.

In the central part of the Appalachian Valley as portrayed on the Loudon, Tennessee, quadrangle, there is a marked accordance of low, linear topographic features which attain a height of about 1000 feet. They are not typical monadnocks, although some of them rise a few feet higher than the general level of the country. Even the higher ones do not rise sharply from the peneplane level. Broad views of an even terrain having an elevation of about 1000 feet are rather common in this region. One of them is reproduced in *Plate XLIII*. In the vicinity of Dayton, Tennessee, the Harrisburg peneplane is splendidly developed at an elevation of 900 to 950 feet. A view looking east from Bryan University shows an even surface that has been much dissected in post-Harrisburg time. A short distance south of Dayton the surface is equally even and is sharply contrasted with the Schooley level preserved on Walden Ridge to the west. This is brought out in *Plate XLIV*.

Near the southern end of the Appalachian Valley province in central Alabama, Carboniferous shales come in direct contact with the Talladega slates which underlie the western portion of the Piedmont. This unusual relationship, in which late Paleozoic shale, with limestone members, forms the floor of the Appalachian Valley while older, undifferentiated slates underlie the adjacent

part of the Piedmont, is due to a fault between the two provinces. The area underlain by shale has been reduced to an even lowland which seems to represent the Harrisburg peneplane because it correlates normally with better known Harrisburg areas to the north. Its altitude here is approximately 600 feet, and its general character may be seen by an examination of *Plate XLV*.

In the preceding pages a few typical remnants of the Harrisburg peneplane between the New-Holston divide and the southern end of the province have been described. The writer does not wish to leave the impression that the elevations given for the different remnants are more than approximately correct. The greatest difficulty in determining the present elevation of the erosion surface lies in the high solubility of many of the limestone formations. For instance, near Abingdon, Virginia, the much dissected shale belt known as Great Knobs stands 100 feet or more above the adjacent limestone region where there is a rather marked accordance of hilltops. The writer is of the opinion that the shale hills represent rather closely the present position of the peneplane, while the limestone surface, because of its greater areal extent and its general evenness, is apparently an equally characteristic peneplane remnant. In general, the writer has not taken the elevations of the lower limestone belts for the peneplane but rather those of the higher surfaces along the divides. There again, the distinction between peneplane remnants and low monadnocks is a difficult one to make.

The conclusion is forced upon us that the erosive work of the Harrisburg cycle was responsible for many of the features of the Newer Appalachians of the South. Aside from the broad limestone lowlands developed in post-Harrisburg time, none of the larger features are more recent in origin than the Harrisburg.

In his "Physiography of the Chattanooga District", Hayes describes a surface which he calls the "Highland Rim Peneplain." It is typically developed in the region known as the Highland Rim lying west of the Cumberland Escarpment. While this peneplane, according to Hayes, stands higher than the Harrisburg as described by the present writer, it is probable that they are really the same. Hayes (37) explains its development and preservation in the following paragraphs:

"*Development and preservation in the valley belt.*—In the valley belt the peneplain was generally developed, although its surface was probably not so near a perfect plain as on the Highland Rim, since the rocks encountered are much more variable in composition and the different varieties occur in long, narrow strips. The degradation of the several varieties goes on at different rates, so that while some areas were perfectly reduced others lagged slightly behind and formed low monadnocks to the end of the base-leveling epoch. The conditions which were unfavorable for uniform reduction were also unfavorable for the preservation of the plain, so that no considerable areas are preserved in the valley belt. Nevertheless, to an observer looking across the belt from any altitude above 1,000 feet on either side the existence of a peneplain is at once manifest. The great majority of hills and ridges reach nearly to a common altitude, above which a few, as White Oak and Chattooga mountains, stand up conspicuously. The peneplain, so far as it is preserved at all, throughout the valley belt is upon rocks of intermediate resistance, chiefly siliceous limestones and sandy shales. Considerable areas of such rocks occur southeast of the Coosa Valley, and in these the peneplain is fairly well shown. In the narrow anticlinal valleys some areas are preserved upon limestones, but this is due to favorable location and the presence near by of massive residuals.

Altitude and deformation.—Elsewhere in the Appalachian province a peneplain, probably corresponding in age to the one under consideration, shows decided deformation, but within the limits of this district the Highland Rim plain retains a very uniform altitude. Upon the Highland Rim it is approximately 1,000 feet above sea level, while in the valley belt its altitude is about 1,150 feet at the northeastern corner of the district and 950 feet at the southern edge. This difference in altitude of 200 feet is doubtless two or three times as great as the difference which prevailed in the same region during the base-leveling epoch, and hence the district has suffered a slight southward tilting since the formation of the peneplain and probably also a slight differential elevation along a meridian passing a little west of Chattanooga."

From an examination of the maps accompanying Hayes' essay it is apparent that the "Highland Rim Peneplain" is not extensively represented in the Chattanooga area, due to later erosion. The present writer would give slightly lower elevations for the Harrisburg peneplane than Hayes gave for the Highland Rim. Thus, in the northeastern corner of the Chattanooga district near Kingston, Tennessee, Hayes assigns it an elevation of 1150 feet, while the present writer would place it about 1000 feet. From this locality it descends to approximately 800 feet at Chattanooga. Then it rises to 900 feet or more on the Tennessee-Coosa divide from which point it descends again in the direction of the Coosa drainage to an altitude of 800 to 850 feet in the vicinity of Cedartown, Georgia.

THE POST-HARRISBURG CYCLE

As we undertake the study of the more recent erosion record the question naturally arises whether all post-Harrisburg time comprises just one cycle, or whether it has been broken into two or more partial cycles by uplift. This problem received consideration in Part I of this study, and the tentative conclusion reached was that no features in the present topography have been found by the writer which require an additional cycle or cycles. He did not deny the existence of such partial cycles, but rather preferred to keep an open mind until convincing evidence is forthcoming. There are terraces, as noted below, along some of the master streams, and an occasional bench high above the present valley floor which could be explained on the basis of extra cycles of erosion. Some measurements with the alidade have been made but not enough to confirm conclusively the general impression in the mind of the writer that these terraces are not correlatable with any movement of the earth's crust. Further study along this line is contemplated.

Since the close of the Harrisburg cycle stream erosion has reduced the soft rock belts which has tended to emphasize the low monadnock ridges, resulting in a very definite corrugation in the present topography. This brings out very clearly the northeast-southwest trend of the rock structure in many parts of the Appalachian Valley, as in the northern portion of the Cleveland, Tennessee, quadrangle, as well as in the Ridges. There are some areas, however, which lack this definite grain in the topography, as, for instance, the southeastern part of the Rome, Georgia-Alabama, quadrangle, where the topography shows practically no trend in any direction. The tributaries of the Etowah River in this locality have a pattern which is more dendritic than trellis. The region is underlain by Knox dolomite in an almost horizontal position, which accounts for the absence of any distinctive trend in the topography. This is one of the largest and most typical areas of the Appalachian Valley where the normal linear elements in the topography are lacking.

Solution in the limestone areas has been one of the most active processes in the destruction of the Harrisburg peneplane. There

are many areas on belts of limestones and calcareous shales which have been reduced to elevations between the Harrisburg surface and the present stream levels. In view of the fact that some of the lowlands are drained by tiny streams while in others there is no surface outlet at all, we are led to the conclusion that solution has been a dominant process. These lowlands are often not true stream valleys at all, but depend for their width and extent upon the distribution of soluble rocks.

Some lowlands are underlain by shale, in some of which solution has been important because of their calcareous nature. In other places, especially where the shale belts are occupied by widely meandering streams, it appears that the dominant process involved in their reduction has been lateral corrasion. As noted in Part I, many of the streams that are known for the width of their meander belts are located on shale. This leads one to believe that shale is mechanically weak. It must be obvious to everyone that it is impossible to separate entirely the work of corrasion and planation on the one hand from erosion by solution on the other, and that both of these processes have been active.

Two of the most typical features of the post-Harrisburg erosion cycle are the broad lowlands previously mentioned and the occasional benches or terraces in the valleys of the present streams. In addition to these, the stage of development of the present valleys is worthy of attention. These subjects will be taken up in the following paragraphs.

Modern Stream Valleys

Within the Appalachian Valley the streams vary in stage of development from youth to maturity, with the majority of the larger streams representing the latter stage. Almost all of the master streams, especially where they occupy subsequent valleys, have floodplains and meanders. A straight stretch of the Holston River, near Knoxville, Tennessee, is shown in *Plate XLVI*, while a typical meander of the Tennessee River near Loudon, Tennessee, is reproduced in *Plate XLVII*. Even much smaller streams have extensive floodplains. This is shown in the case of the Conasauga River, flowing from north to south through the

Dalton, Tennessee, quadrangle. It meanders on a very wide floodplain. A typical view showing its graded course is seen in *Plate XLVIII*.

As a general proposition the streams and valleys of the Appalachian Ridges are younger than those of the Appalachian Valley. The lateral tributaries of subsequent streams, flowing down steep slopes, are frequently quite youthful in character. Lookout Mountain, an outlier of the Appalachian Plateau from which it is separated by a longitudinal subsequent valley, as seen in *Plate XXVII*, is capped by resistant sandstone over which the streams cascade. The most youthful streams of the region are found in such situations. A particularly good example is shown in *Plate XLIX* where Noccalula Falls occur on Black Creek. A more striking contrast is seldom seen than when one turns from this waterfall on Lookout Mountain and views to the east the broad lowland through which the Coosa River meanders grandly. These two streams represent the opposite extremes in stage of development in this area.

Stream Terraces

An examination of the terraces along the Holston River above and below Kingsport, Tennessee, revealed the presence of several bench-like features which indicate different floodplain levels of a slowly degrading stream. On the north side of the river there is a floodplain terrace rising approximately twenty feet above the modern floodplain of the Holston River. Then there is a higher terrace composed of shale overlain by stream gravels about thirty-five feet above the floodplain. Following U. S. Highway No. 11 to the north one crosses a rather poorly defined bench at an elevation of about 1300 or 1350 feet. This feature is very much dissected and so far as could be determined it is without a cover of stream gravels. It is developed on inclined limestone beds, and occurs about halfway between the present stream level and the Harrisburg peneplane, which has an elevation of approximately 1500 feet at this point.

A similar bench extends southwest from Kingsport along the northwest side of the Holston River valley. Near the village of

New Canton (Estillville, Kentucky-Virginia-Tennessee, quadrangle) it has an elevation of 1300 feet and is developed on limestone. On its surface occasional rounded gravels are found. Farther southwest a similar feature occurs around Surgoinsville, and it extends to and beyond Yellow Store. At the latter point there are rounded gravels on the surface of the bench, which is here about 150 feet above the level of the Holston River. This is one of the most persistent benches, having a rather uniform elevation and covered in places with gravels, that the writer has seen in the Southern Appalachians. It would seem to mark the close of a partial cycle, but before committing ourselves to this interpretation we must consider the possibility of a structural origin. Knox dolomite underlies most of the bench while the Sevier and Athens shales occupy the valley floor. Where even surfaces are underlain by soluble rock it is usually not safe to interpret them as definite erosion levels unless there is other supporting evidence.

Floodplain terraces are found at various places along the larger streams, as, for instance, near Elizabethton, Tennessee, where the Doe River unites with the Watauga River. Two terraces with relatively broad, almost flat surfaces occur in the city of Elizabethton. Both carry some stream-worn gravels. The lower stands about forty feet above the floodplain of the Watauga River, and the upper is separated from the lower by about the same interval. The Watauga River is flowing at present against the northwest wall of its valley, while the terraces are found on the southeast side. These features would seem to require no special explanation.

The Tennessee River likewise has terraces, some of which are covered by stream gravels. A broad, moderately dissected terrace carrying stream gravels, occurs around Harrison, Tennessee, just south of the junction of the Hiwassee and Tennessee Rivers northeast of Chattanooga, Tennessee. Its elevation above the present floodplain of the Tennessee River was measured and found to be thirty two feet.

Gravel-capped hills were found east of King Point, a half dozen miles northeast of Chattanooga on the east side of the

Tennessee River. These occur at an elevation of nearly 800 feet, which is just a little below the Harrisburg level in this region, and could easily represent river deposits made during the closing stages of that cycle. Gravels were found at several other points in this vicinity at approximately the same elevation, estimated to be a little below the 800 foot contour, and, therefore, about fifty feet below the Harrisburg peneplane.

Observations on terraces were made in many of the valleys of the region covered by this paper. The writer does not wish to commit himself at present as to their possible cyclical meaning, because they have not yet been studied in sufficient detail to justify a conclusion. Several facts, however, are obvious. In the first place, they are not at uniform elevations above the present valley floors. They are, furthermore, very irregular in the extent of their development and also quite variable in number even in different parts of the same valley.

In this study of the benches and terraces associated with the river valleys of this region, the writer has examined the following points: first, the presence or absence of flat, or nearly flat, surfaces at any elevation between the present valley floor and the hilltops on either side of the valley which preserve the Harrisburg level. It is necessary to go back from the walls of the present valley in order to determine whether the entire modern valley may have been excavated out of a still broader valley developed in a cycle immediately following the Harrisburg. Second, the slopes of such surfaces; also the extent of dissection since their formation. Third, their continuity upstream and downstream from points where they are typically developed. Fourth, their relation to the present valley, and also to the Harrisburg peneplane. It is quite important to be sure that there is a distinctness about these features, and that they are set off from the work of possible earlier or later partial cycles. Fifth, the presence of water-worn gravels on their surfaces, and the age, degree of rounding, and abundance of these gravels. Sixth, their relation to slipoff slopes of meander spurs. The absence of terraces on the gentle slopes of meander spurs would cast some doubt as to the occurrence of an interruption in the downcutting of a rejuvenated stream.

After pursuing the above lines in this rather general study of terraces the writer does not regard them as strong evidence in support of an extra cycle or cycles. Furthermore, other explanations seem equally plausible in the case of most if not all of them. Some apparently owe their existence to soluble limestones occurring in a narrow strip along one or both sides of the valley. To this may be added favorable structure where the beds are locally nearly horizontal. Others, particularly the highest ones, appear to be merely the remnants of the floodplains of Harrisburg time. In the valley of the New River, for instance, there is a broad, high, boulder-strewn bench which borders Harrisburg hills on the surface of which there is not a trace of stream gravels. This situation would seem to find its explanation in the natural relation of a valley bottom to its adjacent upland. The terraces on the floors of present valleys have certainly no meaning apart from the normal development of mature valleys. Finally, some terraces would be apt to remain as local traces of former valley floors in any normal stream valley where downcutting has not been too rapid.

Interstream Areas

The nature and extent of post-Harrisburg dissection of the interstream areas vary greatly from place to place. There are few flat remnants of the Harrisburg peneplane, and all parts of its surface have been reduced to a greater or less degree. This is quite expectable in view of the fact that the areas where the Harrisburg was best developed are also the areas where it would be most dissected.

There are several different types of interstream areas due to the nature of the dissection in the present cycle. Some have been reduced quite evenly, largely by solution, so that they appear to be true remnants of a peneplane. By comparison with neighboring areas, however, where the peneplane has been less eroded and hence better preserved, it is found that some of the most even surfaces are appreciably below the Harrisburg peneplane.

Another type of post-Harrisburg erosion is found in areas underlain by shale. Here the Harrisburg peneplane may be preserved on the summits of innumerable hills which are sep-

arated by an intricate series of valleys. The valley sides are steep and frequently smooth as is common in shale areas. This type of topography is not found in all parts of the Valley, but it is very unique where typically developed in such areas as The Knobs near Newport, Tennessee, as shown in *Plate XLII*.

In the Chattanooga region a very characteristic type of topography has been produced by dissection in the present cycle. It consists of a series of parallel chert ridges separated by broad lowlands or flats (*Plate XXXIII*). The ridges themselves are above the Harrisburg peneplane, while the broad lowlands like that of South Chickamauga Creek are appreciably below it. In the areas where this type of topography is extensively developed there are scant traces of the Harrisburg peneplane. The lowlands are all underlain by soft rock, limestone or weak shale, as explained by Hayes (37). According to this author, they represent an erosion surface which he calls the Coosa Peneplain. The lowlands are wider in this region and nearer the level of the present streams than they are in the northern part of Tennessee. They have such a large areal extent and constitute such an important element in the topography that they justify careful consideration. The author prefers to use the name Coosa lowland for these features as this term is non-committal as regards their origin.

Coosa Lowlands

Among the most distinctive features of the southern part of the Appalachian Valley province, particularly between Knoxville, Tennessee, and Birmingham, Alabama, are the lowlands which occur in many of the strike valleys. Some of them border the floodplains of subsequent streams, above which they rise usually less than one hundred feet. Others are located between minor ridges and are drained by tiny streams or by subsurface discharge. They are underlain mainly by limestone and calcareous shale, and their extent is limited by the occurrence of rocks of this type.

C. W. Hayes (37) described these lowlands and applied to them the name "Coosa Peneplain." As an alternative explanation the present writer wishes to suggest that they may have been formed

largely through solution, but partly by corrasion, during the present cycle of erosion.

In the above-mentioned paper entitled "Physiography of the Chattanooga district, in Tennessee, Georgia, and Alabama", the author draws special attention to the nature and distribution of the Coosa Flats which he interprets as a peneplane younger than the Highland Rim. His description of these lowlands follows:

"*The valley lowlands.*—No extensive areas of level country are found in this district except in its southern portion along the Coosa River. From the vicinity of Rome, extending southwestward, the Coosa lowlands, or 'flatwoods,' as they are locally called, form a belt 10 or 12 miles wide but little above the narrow flood plain of the river. This lowland is developed entirely upon soft or soluble rocks, and where the Coosa flows upon more resistant formations it is confined to a comparatively narrow valley. The same is true of the Tennessee and all other streams, both large and small; the extent of the bordering lowland is dependent directly upon the nature of the underlying rocks.

Starting, then, with the level of the larger streams, as the Tennessee and Coosa, between 600 and 700 feet above tide, there is generally, though not always, a strip of flood plain, and a short distance above this a strip of level lowland which is never reached by the present floods. The extent of the flood plain depends upon the size of the stream and the character of the underlying rocks, while the higher plain depends chiefly upon the latter factor."

Continuing on a later page,

"The Coosa 'flatwoods' constitute the largest area of the peneplain. This region is underlain by calcareous shales and limestones, which are planed off to a level surface, on which are frequently formed deposits of gravel and silt. These unconsolidated deposits appear to have been connected with the final stages of the base-leveling epoch, or possibly with the oscillations and changes in grade which closed the epoch. Their presence indicates its recency. . . .

"*Altitude and deformation.*—The altitude of the Coosa peneplain is something over 700 feet at the southern edge of the district and about 100 feet higher at the northern edge. This slope is but little more than the normal grade of a base-leveling stream, so that the region has probably suffered only a slight deformation since the close of the last gradation period. When examined in minute detail considerable variation is discovered in the altitude of various portions of this peneplain. Also base-leveled surfaces are found at all altitudes up to and even above the next higher peneplain. These are not to be taken as indicating distinct base-leveling epochs, but simply as representing the influence of local conditions. They depend upon the existence of *local* base-levels and are to a large extent independent of the *general* base-level. They illustrate the extreme complexity of the gradation process when followed into its details and the manner in which

every possible phase of the process may generally be found in a single region of moderate extent."

In the following pages a few typical examples of these lowlands will be described briefly. The plates which accompany the descriptions bring out clearly their nature.

In a limestone area northeast of Cleveland, Tennessee, there is a basin bordered by gentle slopes underlain by Knox dolomite and Conasauga shale. It is somewhat below the level of the Harrisburg peneplane, but considerably above the floors of the main valleys, and is drained by tributaries of South Mouse Creek. A typical view of this feature is shown in *Plate L*. This lowland is not a valley produced by corrasion but a depression due largely to solution. There are no distinct valley walls. The slopes rise gently from the middle to the low ridges on either side. This is an example of the lowlands that are not associated with large streams.

On a broad northeast-southwest trending belt of Conasauga shale, southeast of Cleveland, Tennessee, Coahulla Creek, even near its head, flows through a very flat-floored lowland. The Conasauga shale is described as a clay shale with limestone beds. On the Cleveland quadrangle this open basin is several miles in width, which is a much broader valley than a stream the size of Coahulla Creek would be expected to develop. A part of the late mature surface of this basin is shown in *Plate LI*.

The valley of South Chickamauga Creek, a few miles east of Chattanooga, is an especially good example of a Coosa lowland underlain by Knox dolomite and Chickamauga limestone. The gently sloping surface bordering this valley slopes down almost imperceptibly to the floodplain, as seen in *Plate LII*. The photograph was taken from a point on the lower slope of the limestone lowland and looks across the floodplain to a highway bridge across South Chickamauga Creek, which may be seen on the extreme right. The Chattanooga folio (30) shows that the limestones underlying this basin are practically horizontal.

A very broad expanse of low-lying terrain is found in the northern part of the Ringgold, Tennessee-Georgia, quadrangle, just south of the area previously described. It is also underlain

by the same rock types as in the northern district; and the structure is, likewise, essentially horizontal. A typical view of this lowland as developed in Chickamauga Park, is shown in *Plate LIII*. Limestone outcrops on its floor.

The extensive flat bordering the Coosa River from Rome, Georgia, southwestward fifty miles to Gadsden, Alabama, is the type area of the Coosa lowland. It continues south of Gadsden with some interruptions and is broadly developed on the Springville, Alabama, quadrangle. Its general characteristics were described by Hayes in the quotations given above. It has a width of approximately twelve miles, an elevation for the most part between 600 and 700 feet, and is the largest and possibly the most even of all the Coosa lowlands. It is really a late mature topography which has been elevated but slightly if at all. The Coosa River itself is approaching late maturity. The lowland is underlain entirely by limestones and shales with patches of unconsolidated materials distributed over its surface. A long range view of this lowland showing the rimming mountains on the north and east as they appear from the east slope of Lookout Mountain is reproduced in *Plate LIV*. Whatever the origin of this surface may be, it is one of the most striking lowlands of the southern Appalachians. Few points within its area rise more than 100 feet above the level of the Coosa River.

A final example of the Coosa lowland is Jones Valley between Birmingham and Bessemer, Alabama. It swings around the southern end of Flint Ridge near Bessemer and ties up with Opossum Valley to the west. These Valleys are almost flat, and are not drained by large streams. The surfaces of these valley floors rise usually less than forty feet above the present stream levels, and the basins are entirely developed on calcareous members of the Conasauga and Ketona formations. The latter is a dolomite. A view looking across Bessemer shows this flat area in the middle ground with the Carboniferous escarpment in the distance (*Plate LV*).

A sufficient number of these lowlands has been described to give the reader a fair impression of their characteristics. Hayes explained them as being parts of the "Coosa Peneplain." This

explanation would, of course, involve a cycle of erosion between the Harrisburg and the present during which these basin floors were eroded. The writer wishes to present an alternative explanation, placing them in the present cycle which may have continued without serious interruption since the close of the Harrisburg. Let us consider the criteria by which we should judge whether the Coosa lowlands constitute a peneplane or merely late mature topography produced during the post-Harrisburg cycle on extremely weak and highly soluble rock.

1. If the surfaces of these basins are the remnants of a peneplane, they should be separated from the Harrisburg surface and the present valley floors by breaks in the slopes. They should be moderately flat, bench-like features definitely separated from the present valley bottoms. The writer has traversed the lowlands described in the preceding paragraphs, as well as many others, and he is unable to discover a sharp break between the Coosa lowlands and the present valley bottoms. Furthermore, in many cases they are not flat but slope rather uniformly from the bases of higher hills and ridges down to the level of the present floodplain. Illustrations may be seen in *Plates L* and *LII*. This point will probably not be fully clarified until very accurate profiles, based on instrumental measurements, are constructed.

2. In the different, or at least in neighboring, basins, these surfaces should occur at about the same elevation above the present streams. This is apparently not the case in those studied by the writer.

3. They should normally rise upstream with gradients a little less than those of the present streams, until near the heads of the valleys they should approach the level of the Harrisburg surface. This seems to be true in some of the basins, as, for example, near the head of Coahulla Creek, shown in *Plate LI*. In others, such as the Coosa lowland, between Rome, Georgia, and Gadsden, Alabama, and also the Jones and Opossum Valleys near Bessemer, Alabama, they do not seem to follow this plan.

4. The extent of their development, as parts of a peneplane, should be governed by the size of the stream as well as by the areal extent of the weak rock belt. Apparently, the size of the

stream has little to do with the extent of their development, which seems dependent almost entirely upon the width and breadth of the area underlain by soluble rocks or very weak shale. The Beans lowland north of Morristown, Tennessee, and the Powell Valley south of Cumberland Gap are limestone lowlands without through-flowing streams. Most of the drainage of Powell Valley is subterranean, and the development of this lowland appears to be undoubtedly due to solution.

5. If the Coosa lowlands are parts of a recently formed peneplane that has been uplifted, they should show dissection by rejuvenated streams. Even the largest of these lowlands, the Coosa, bears no sign of rejuvenation. In fact, the Coosa River is a mature or late mature stream in the present cycle. *Plate XLVIII* shows a typical stream flowing through one of these lowlands.

As stated above, it appears more logical to interpret these features as products of the present cycle, until more satisfactory evidence of an additional cycle is revealed. They range in stage of development from mature to late mature, or early old age.

It has been noted that all of these basins are underlain by soluble rocks, most of which are limestone or dolomite or calcareous shale. Corrasion, of course, has been active. It is the conviction of the writer, however, that solution has played a much larger rôle here than in the northern part of the Appalachian Valley. This would seem reasonable in view of the shorter winters and the higher annual temperature combined with heavier rainfall. The chert ridges of the Chattanooga district seldom display an exposure of bedrock. Instead, there is a very deep residual cover consisting largely of cherty clay. This indicates the removal of the lime content to great depth. The insoluble material is left behind as a deep soil mantle. In the limestone lowlands it is difficult to appraise the relative parts played by solution and corrasion, but where tiny streams drain flats several miles in width, reduction by solution is strongly suggested. In some areas where the main drainage is undergound, the surface is reduced uniformly by solution. Such a region usually resembles a peneplane although it probably does not actually represent

a cyclical surface. The extent of development of the Coosa lowlands is doubtless due in part to the great number of subsequent streams, which facilitates the rapid removal of material either in suspension or by solution.

From the foregoing we conclude tentatively the following, which, if substantiated, ought to aid in unraveling the erosional history of this region:

1. Solution appears to play a much more important rôle in the erosion of southern than of northern limestone regions, due, perhaps, to greater rainfall, higher temperatures, and shorter winters. Horizontal, or nearly horizontal, structure seems to favor chemical decay.

2. Due to the large percentage of precipitation which goes directly underground in limestone regions, it is probable that the surfaces of such areas may be lowered uniformly, largely through solution, so that at any stage in the cycle there would be even surfaces standing at various elevations above base level in different basins.

3. Coosa lowlands on this hypothesis would be explained as mature to late mature surfaces without cyclic meaning.

Local Features

Several of the most unique features of local interest will be briefly described.

BURKE GARDEN

Burke Garden is located in Tazewell County, Virginia, about twelve miles southwest of Bluefield, West Virginia. It is an oval-shaped basin more than six miles long, rimmed by mountains except where the rim is broken by the gap of a single outlet stream. The elevation of its gently rolling limestone floor is approximately 3100 feet, while the surrounding mountains rise from 800 to 1500 feet higher. The one outlet stream discharges to the north.

Much of the drainage disappears through limestone sinks. This veritable garden spot, surrounded by mountains, supports a heavy Blue Grass sod. It originated through the unroofing of a domal fold from the arch of which the resistant Clinch sandstone has been removed by erosion.

NATURAL TUNNEL

Natural Tunnel, in Scott County, Virginia, is a few miles south of Big Stone Gap. It lies within the Appalachian Ridges province on the Estillville, Kentucky-Virginia-Tennessee, quadrangle. It forms part of the channel of Stock Creek and also accommodates the tracks of the Appalachian division of the Southern Railway. The Tunnel, formed in Copper Ridge dolomite, has a length, including the "amphitheatre", of 1557 feet, an average width of 130 feet, and an average height of 100 feet. An underground piracy, which diverted the head of a tributary of the North Fork of Clinch River southeastward to the Clinch River, was responsible for its formation.

The two streams formerly flowed southwest in parallel subsequent valleys separated by Purchase Ridge. The bed of the Clinch River was several hundred feet below that of its tributary, the North Fork, which joined it some fifteen miles downstream. An underground channel through Purchase Ridge was developed by solution; and, aided, doubtless, by the headward growth of a short tributary of the Clinch River, the drainage of the higher subsequent valley northwest of the ridge was diverted through a direct course to the master stream.

The present divide in the abandoned subsequent valley between the beheaded tributary of the North Fork of Clinch River and the captured stream is at Hortons Summit. At this locality are found abundant rounded and partly rounded boulders which occur lower on the slope than we should expect the bed of the former stream; but it is possible that they have slumped down and later been buried beneath debris brought down by slope wash. The degree of rounding of many of the boulders is no greater than would be normally expected in material that had rolled down from the adjacent mountains.

An impression of the size of the Tunnel may be gained from *Plate LVI*, which shows the exit, locally known as The Crater.

LIMESTONE SINKS

Sinks in the soluble members of the Paleozoic formations are widely distributed in the Appalachian Valley as well as in the Appalachian Ridges. The extent of their development seems to be dependent upon the solubility of the rock as well as upon such structures as jointing and bedding. The dip of the beds also influences their number and distribution. A typical view of sink topography may be seen in *Plate LVII*.

The results of solution in the limestone areas are not restricted to sinks. Caves occur in different parts of the province. One of best known of the southern caverns is Indian Cave, near Jefferson City, Tennessee.

SUPERPOSED DRAINAGE

A portion of Part I of this paper is devoted to superposed drainage, by reason of the fact that all of the master streams north of the Tennessee pass out of the Appalachian Valley to the northwest or southeast across mountain barriers. In the area under consideration, there is just one impressive example of superposition, that of the Tennessee River west of Chattanooga, Tennessee. It is true that there are streams in the Appalachian Valley which flow across the grain of the country where it would seem more normal to follow the belts of weak rock. A typical example of this is shown on the lower course of the Clinch River, which joins the Tennessee River at Kingston, Tennessee. In the north central part of the Loudon, Tennessee, quadrangle, the Clinch River changes abruptly from a southwesterly course to a westerly one. This approximately doubles the length of its lower course and takes it across the low ridges of the region which it could have avoided by continuing its subsequent course direct to the Tennessee River.

In the Appalachian Ridges of southwestern Virginia, particularly in the area covered by the Estillville quadrangle, are a number of water gaps occupied by minor streams flowing southeast-

ward. Big Stone and Big Moccasin Gaps are the outstanding examples. Superpositions are also found on some of the minor, northeast-flowing tributaries of the New River. A prominent ridge, Rich Mountain, is bisected by Wolf Creek at Rocky Gap, and Little Walker Creek is cutting through Walker Mountain about ten miles south of Pearisburg, Virginia, on the Dublin, Virginia-West Virginia, quadrangle. Just south of the latter gap, and directly in line with it, is a pronounced wind gap in Little Walker Mountain, or rather between it and Cloyds Mountain, which is a continuation of Little Walker Mountain toward the northeast. It has a depth of 500 feet and obviously was once the outlet for a part of the drainage which now passes eastward by Back Creek along a subsequent course direct to the New River. This piracy was accomplished with little difficulty due to the strong contrast in resistance between the rocks composing the ridge and those underlying the subsequent valley of Back Creek.

It is interesting to note that the last group of superpositions involve streams that flow north or northwest toward the Plateau while those in the southwestern section of Virginia flow south or southeast toward the Appalachian Valley. This same condition was observed in the northern part of the Newer Appalachians of the South, which suggests that the agencies of superposition operated uniformly over wide areas.

Johnson (39) has shown that the Tennessee River was not diverted westward across Walden Ridge, west of Chattanooga, from a southwesterly course as set forth by Hayes and Campbell (34), and by Hayes (37) alone, but that it has had its present superposed position across Walden Ridge since an early date in the erosional history of the region. His conclusion is: "It may be said in general, however, that it appears that all of these features may be interpreted in accordance with the theory that the Tennessee River has held its present course since near the close of the Cretaceous period." The observations of the present writer are in entire accord with this interpretation. In addition to the evidence presented by Johnson in support of his conclusion one might consider the fact that the Harrisburg peneplane slopes northward toward Chattanooga from the divide between the

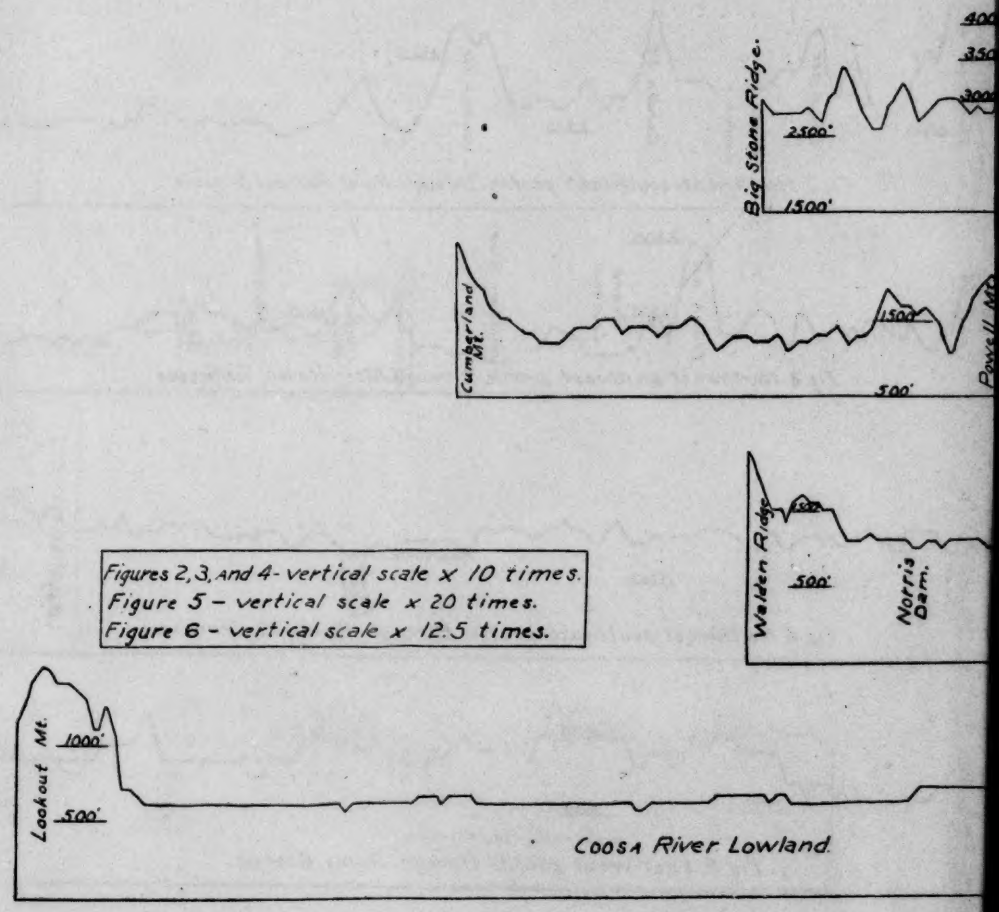
Tennessee and Coosa Rivers. Its elevation on the divide is a little under 1000 feet, possibly not much above 900 feet, while at Chattanooga it is about 800 feet. Furthermore, the profiles reveal clearly a gentle downward slope of the surface in that direction. Since the peneplane slopes to the north it is obvious that the Harrisburg streams which formed it must have flowed in that direction. This evidence is opposed to a southward continuation of the Tennessee River, during the Harrisburg cycle, across the present Tennessee-Coosa divide. The question still unsolved is the cause of the superposition. The Tennessee River probably developed its broad meanders across Walden Ridge in the latter part of the Schooley cycle. The superposition, which came earlier, may have been due to a cover of marine sediments. The gorge of the Tennessee River just west of Chattanooga is one of the picturesque young valleys of the region. A view of the upper part of the gorge as seen from Signal Hill appears in *Plate LVIII*.

TYPICAL NORTHWEST-SOUTHEAST PROFILES ACROSS THE PROVINCE

In the following pages an attempt will be made to convey an impression of the topography of the Newer Appalachians of the South by describing five transverse profiles, four of which extend from the Plateau on the northwest to the Older Appalachian Mountains on the southeast.

These descriptions are presented for two purposes. First, the profiles show the elements of the topography in their natural relations. On preceding pages the topographic features of the region have been placed in their various categories in the erosional history.

The second purpose is to provide an opportunity for a genetic explanation of topographic features in a running traverse across the province. Some of them have definite cyclical meaning, and their place in the erosional history will be indicated. Others have their explanation in structural conditions of a variety of types. The most diversified of these profiles, like the one through Morristown, Tennessee, show a variety of forms, some of which are cyclic and some non-cyclic in meaning.



Figures 2, 3, and 4 - vertical scale x 10 times.
Figure 5 - vertical scale x 20 times.
Figure 6 - vertical scale x 12.5 times.

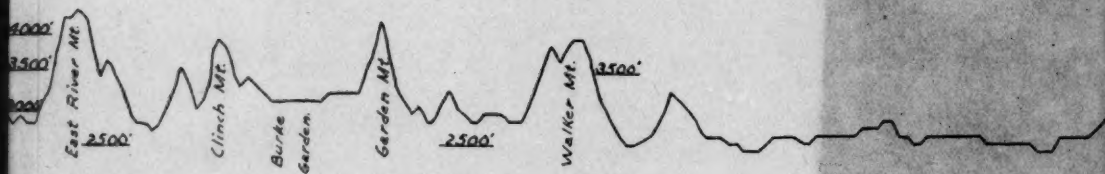


Fig. 2 Northwest-southeast profile through Rural Retreat, Virginia.

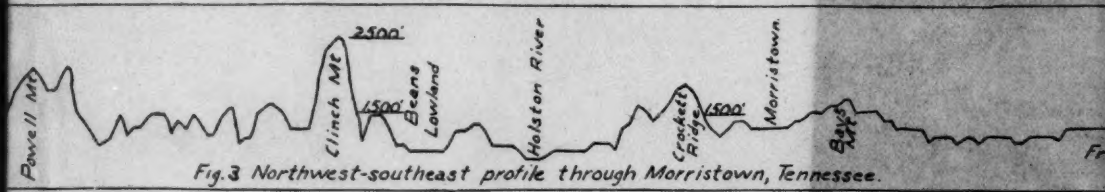


Fig. 3 Northwest-southeast profile through Morristown, Tennessee.

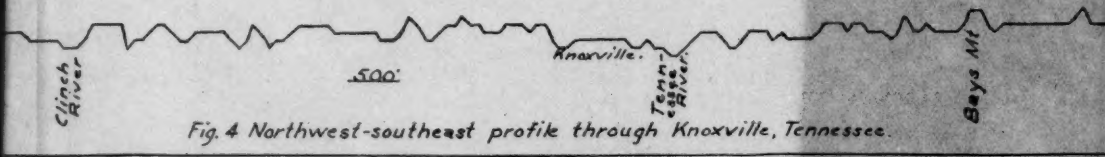


Fig. 4 Northwest-southeast profile through Knoxville, Tennessee.

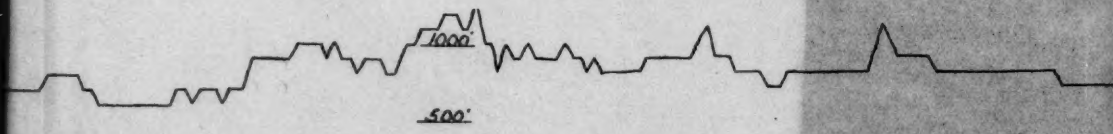


Fig. 5 East-west profile through Rome, Georgia.

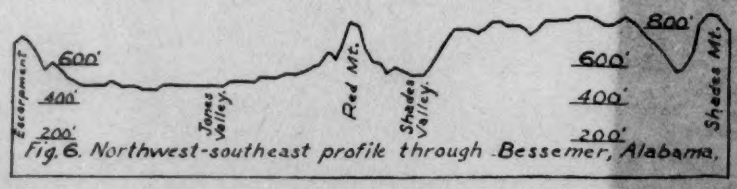
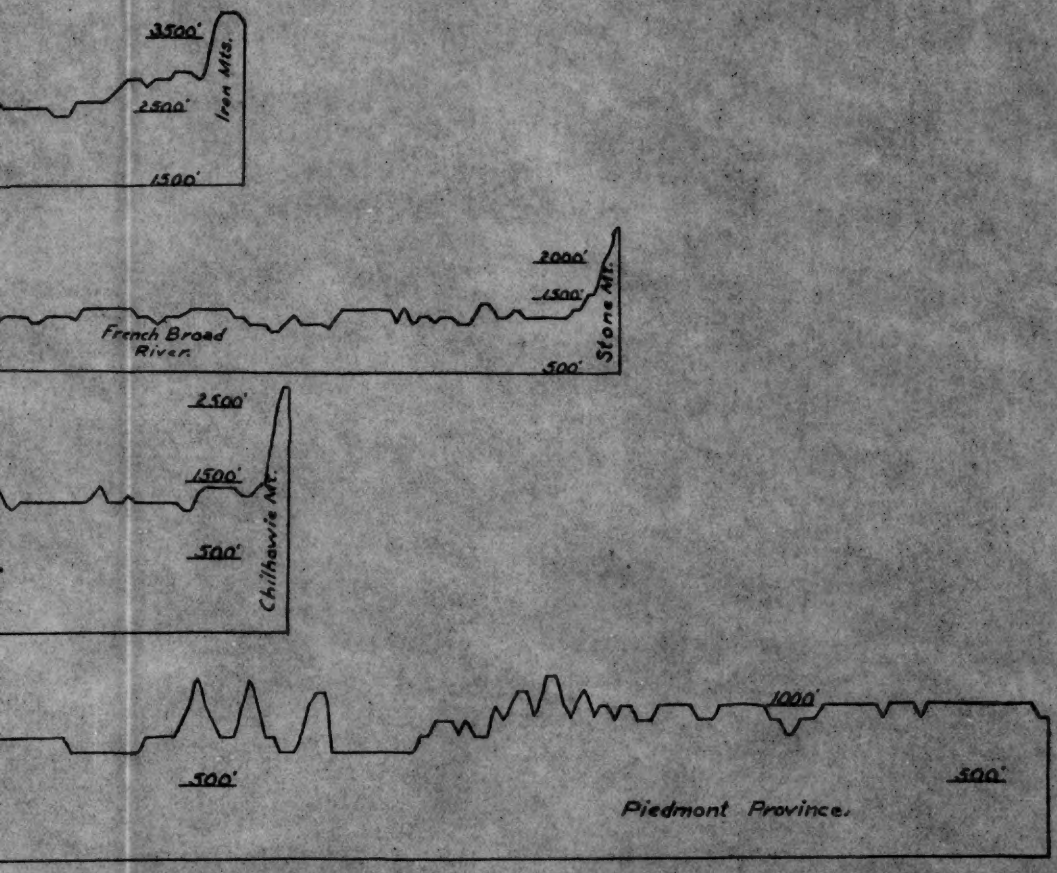


Fig. 6. Northwest-southeast profile through Bessemer, Alabama.

FIGS. 2-6


3500'
Iron Mts.
2500'
1500'
2000'
1500'
Stone Mt.
French Broad
River.
500'
2500'
1500'
500'
Chilhowie Mt.
1000'
500'
500'
Piedmont Province.

Northwest-Southeast Profile Through Rural Retreat, Virginia

In a distance of forty miles this profile traverses the entire belt of the Appalachian Ridges, the Appalachian Valley, and touches the margins of the Plateau on the northwest and the Older Appalachian Mountains on the southeast. Big Stone Ridge marks the southeastern edge of the Appalachian Plateau in this region, while Iron Mountains form the conspicuous northwestern front of the Older Appalachians. This profile is shown in Figure 2 and was drawn from the Pocahontas, Virginia-West Virginia, and the Wytheville, Virginia-North Carolina, quadrangles. This locality was selected because of its location on the New-Holston divide where the Harrisburg peneplane reaches its maximum elevation in the Appalachian Valley. This is, in fact, the highest point on the floor of the Appalachian Valley between northern New York and central Alabama. Furthermore, the remnants of the Schooley peneplane appear to be higher here than in most parts of the Southern Appalachians. As pointed out in an earlier paragraph, both peneplanes slope southwest from this region.

Southeast of the Plateau there is a belt of parallel ridges separated by narrow valleys. The highest ridges are developed on Clinch sandstone (Silurian). In several cases the immediately underlying Juniata formation outcrops alongside of the Clinch, thereby increasing the width of exposure of resistant rock. East River, Clinch, Garden, and Walker Mountains are the most prominent ridges in this area and all are due to the resistant Clinch sandstone, or to Clinch and Juniata combined. The lower ridges are underlain by the Juniata formation, or by one of the siliceous members of the Mississippian system, the most important of which is the Price sandstone (Pocono). The Schooley peneplane has an altitude in this section of nearly 3500 feet, but it is impossible to identify it on any single ridge crest. The four high ridges, which have elevations around 4000 feet or more in this locality, seem to be monadnocks. In a group of ridges such as these where the hard rock formations appear in narrow outcrops, uniformity in elevation is not to be expected. This is true because of variations in width of outcrop, degree of resistance, proximity to the major drainage lines, and other

factors. The same ridge frequently varies in elevation from place to place along its crest.

None of the intermontane valleys in this belt of ridges are wide enough to preserve unmistakable remnants of the Harrisburg peneplane. A typical example of these valleys is that of Clear Fork between Rich and Buckhorn Mountains, a short distance northeast of this profile (*Plate XXXIX*). The unique basin known as Burke Garden, described on an earlier page, is traversed by this profile, and is seen as a high-lying basin between Clinch and Garden Mountains. The nearly even surface of its floor may be interpreted as a local development of the Harrisburg peneplane. Such an interpretation would postulate the occurrence of definite traces of a former mature valley leading downstream from the Garden. It is quite possible that Wolf Creek, the outlet stream, did have a graded course to the New River at the close of the Harrisburg cycle, but traces of a former mature valley would have slight chance for preservation in such a narrow subsequent valley. On the other hand, Burke Garden may be interpreted equally well as a limestone basin which is being reduced as rapidly as the outflowing stream lowers its channel.

From the southeastern base of Walker Mountain the Harrisburg peneplane is well developed across the Appalachian Valley to the northwestern base of Iron Mountains. Its surface is preserved at an elevation of 2600 feet on the divide between the New and Holston Rivers (*Plates XXIX* and *XXXVII*).

The most prominent ridge-maker in this part of the Appalachian Ridges is the Silurian Clinch sandstone. The Iron Mountains, southeast of the Appalachian Valley, are underlain for the most part by early Cambrian sandstones and quartzites, flanked on the southeast by pre-Cambrian granite gneiss. They show a considerable range in degree of resistance among the different members of the group as well as within the individual formations themselves. As a result of these variations many topographic features do not fit into a strictly cyclical interpretation of this region.

The profile is typical for this part of the Newer Appalachians. It shows nine ridges on the northwest and the Appalachian Valley

on the southeast. The Schooley peneplane may be preserved in the Ridges, and the Harrisburg peneplane is positively identified in the Appalachian Valley.

Northwest-Southeast Profile Through Morristown, Tennessee

The profile shown in Figure 3, extending from the Cumberland Escarpment on the northwest to the foothills of the Great Smoky Mountains on the southeast, brings out several prominent ridges, a general development of the Harrisburg peneplane, and post-Harrisburg lowlands. It passes through Morristown, Tennessee, being based upon the Cumberland Gap, Kentucky-Virginia-Tennessee, Maynardville, Tennessee, Morristown, Tennessee, and Mt. Guyot, Tennessee-North Carolina, quadrangles.

Pennsylvanian conglomerates, sandstones, and shales form the surface of the Plateau where touched by this profile. The higher ridges, representing approximately the Schooley peneplane level, are formed on Clinch sandstone, which takes its name from Clinch Mountain, the most prominent of the ridges.

The Harrisburg peneplane is well represented, although much dissected. It ranges in elevation from 1500 feet in the Powell River basin on the northwest to 1250 or 1300 feet in the "Knobs" on the southeast. The knob country, an intricately dissected region, illustrating fine-textured topography, maintains the Harrisburg level as described on an earlier page. It is underlain by the Sevier and Athens shales. The former has much the greater areal extent and includes, according to the Morristown folio (46), calcareous sandstone, sandy shale, calcareous shale, and limestone.

The three lowlands, all trending northeast and southwest with the strike of the rock, include the following: a lowland occupied by Mooresburg, Tate Springs, and Beans Station, a lowland passing through Morristown and Jefferson City, widening toward the southwest to Strawberry Plains, and the Lick Creek lowland.

The northwestern member of the group, the Beans Station-Tate Springs-Mooresburg lowland, has a remarkably even surface at an elevation just a trifle higher than that of a minor lowland bordering the Holston River a few miles to the southeast. This is

the more noteworthy when it is seen that there is no through stream in this low belt which is drained by short tributaries of the Holston River. Cambrian limestones and shales underlie most of the southwestern part of the floor and Moccasin limestone (Ordovician) most of the northeastern. Solution was obviously the most important process in the development of this striking lowland. It is bounded on the southeast by Richland Knobs, formed by a cherty division of the Knox dolomite.

The lowland which trends northeast and southwest through Morristown is underlain chiefly by Knox dolomite, a cherty portion of which forms the low-lying Crockett Ridge along the western border of this belt. The lowland is well developed for thirty miles southwest of Morristown, particularly in the area just north of Strawberry Plains through which the Holston River has developed a broadly meandering course. Its elevation is slightly less than the Harrisburg peneplane at Morristown and it descends to the southwest more rapidly than that surface.

Lick Creek lowland, between Morristown and Greeneville, is underlain by the Athens and Sevier shales. The calcareous nature of the Athens renders it soluble. Consequently, it is probably the weaker of the two. It occupies most of the valley floor while the Sevier forms the slopes and the bordering hills. Shales are also weak physically. Hence, one would expect a valley on calcareous shale to advance rapidly toward maturity and old age. The floodplain here is broad, and the flat valley floor rises very gently to the base of Bays Mountain to the northwest.

Northwest-Southeast Profile Through Knoxville, Tennessee

A section of the province totally devoid of prominent ridges is shown in Figure 4. The profile crosses the Clinch and Tennessee Rivers and touches the area involved in Norris Dam. Several low ridges, underlain by cherty portions of the Knox dolomite and other moderately resistant rock, occur northwest of Knoxville. Southeast of this city there is a broad expanse of the Harrisburg surface, beyond which is Bays Mountain, a monadnock on the Harrisburg, underlain by sandstone and shale. A broad limestone lowland on Knox dolomite lies east of this monadnock and

extends northeast and southwest in conformity with the trend of the structure. It passes through Maryville and extends for a considerable distant northeast and southwest of the Little River. The lowland crosses this stream at right angles and its areal extent is obviously determined by the distribution of the underlying soluble rocks. Remnants of the Harrisburg peneplane are found in all parts of the area covered by this profile, with the exception of the bordering mountains and the above-described limestone lowland, which is below that level.

East-West Profile South of Rome, Georgia

Figure 5 is a profile covering a belt of country two miles wide, the northern boundary of which is the parallel of thirty-four degrees and ten minutes. It crosses the entire Cartersville, Georgia, and Rome, Georgia-Alabama, quadrangles, and a part of the Fort Payne, Alabama-Georgia, quadrangle. It differs from the preceding in that it has an east-west course. This profile traverses the entire width of the Appalachian Valley province, touches the eastern part of Lookout Mountain on the west, and covers a portion of the Piedmont on the east. In this latitude the Appalachian Ridges are practically absent, although there are scattered ridges to the north and south. From the standpoint of erosional history this is one of the most instructive profiles in the group.

The impressive feature on the extreme west is Lookout Mountain with its cap of Walden sandstone, which preserves the Schooley level. Its elevation is approximately 1500 feet. The broad belt of lowland just east of Lookout Mountain has a remarkably uniform altitude of 600 feet. No part of it rises more than fifty feet above that elevation nor does any valley bottom drop more than fifty feet below it through a distance of more than twenty miles. This is the type locality of the Coosa lowland previously described (*Plate LIV*). The middle section of the profile shows the extensively developed Harrisburg peneplane at elevations ranging from 800 to 900 feet. The sharp points rising above this part of the profile are due to resistant members of the limestone and shale formations. The eastern fourth of the

profile covers the western section of the Piedmont where the Piedmont peneplane is splendidly developed at an elevation of 1000 feet.

There are thus four very marked levels in this profile, the highest being represented on Lookout Mountain and generally referred to as the Schooley peneplane. The next is the splendidly developed Piedmont peneplane at an elevation of 1000 feet, 100 to 200 feet at most above the Harrisburg peneplane which is developed on limestone in the Appalachian Valley. It would seem reasonable to interpret these two levels as belonging to the same geomorphic cycle. The lower surface has been reduced more than the area to the east and it is probable that the reduction was effected by solution since the close of the cycle. The fourth level (about 600 feet in elevation) is that of the Coosa lowland, the origin of which has already been discussed.

The highly resistant Walden sandstone, preserved in the trough of a shallow syncline, caps Lookout Mountain, which maintains the Schooley level. Limestones and shales, particularly the Knox dolomite and the Conasauga formation, underlie the Appalachian Valley. The siliceous layers in the Conasauga, the shale and sandstone of the Rome formation, and the chert in the Knox dolomite are responsible for most of the eminences which rise above the Harrisburg level. Monadnocks do not characterize the Piedmont peneplane in this locality. This condition is due to the nearly uniform resistance of the underlying crystalline rocks.

The valleys of the Piedmont contrast with those of the Appalachian Valley. The former are narrower and have steep and sharply defined walls. The valleys in the limestone region to the west frequently have very broad floors without distinct bounding walls, indicating greater maturity. The broad floors are bordered by gentle slopes which rise gradually to the adjacent uplands. This is particularly well illustrated in the Cartersville, Georgia, region. The Etowah River flows westward just south of Cartersville and emerges from the Piedmont a short distance southeast of the city. Its tributaries in the Piedmont have much younger valleys than its tributaries, such as Pettit Creek, in the Valley.

It would seem logical to conclude that if a peneplane once extended across both the Piedmont and the Appalachian Valley its surface in the following cycle would be lowered much more rapidly in the Valley where the present streams, even the smaller ones, have in the present cycle developed broad valleys than in the adjoining Piedmont where the valleys are less advanced in the present cycle.

Northwest-Southeast Profile Through Bessemer, Alabama

The features here represented are relatively simple. The plateau escarpment on the west is underlain by Fort Payne chert, while Jones Valley, previously described as a Coosa lowland, is formed on the soluble Conasauga limestone. Red Mountain to the east is upheld by the Red Mountain formation, including sandstone, shale, and iron ore. Floyd shale occurs under the floor of Shades Valley, while the Pottsville formation (Pennsylvanian) underlies Shades Mountain (Fig. 6).

This profile emphasizes the importance of variations in rock resistance in determining the type of topography. Jones Valley and Shades Valley are formed on weak limestones and shale, while siliceous formations underlie the two ridges and the plateau escarpment. The agents of weathering and erosion which are operating on the soluble Conasauga formation are particularly effective in the mild climate of Alabama.

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PLATE XXVII

SUBSEQUENT VALLEY BEHIND LOOKOUT MOUNTAIN (LEFT), OUTLIER OF PLATEAU, NEAR GADSDEN, ALABAMA, LOOKING SOUTHWEST

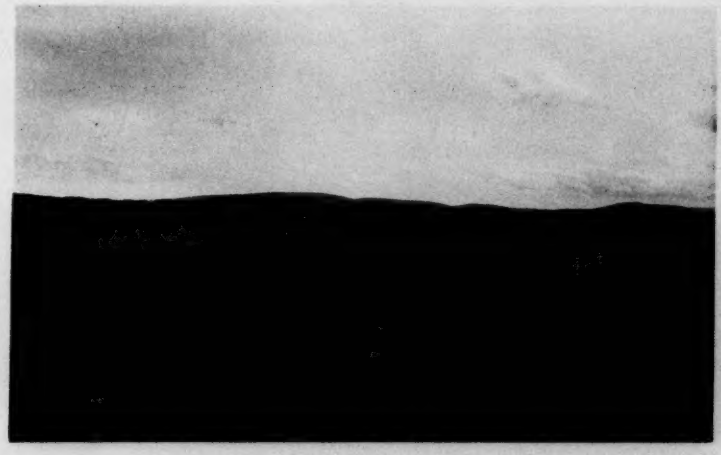

PLATE XXVIII

EVEN SKYLINE OF RICH MOUNTAIN (SCHOOLEY ?), AT AN ELEVATION OF 3500', WITH BUCKHORN MOUNTAIN IN THE MIDDLE GROUND. FROM SUMMIT OF EAST RIVER MOUNTAIN SOUTH OF BLUEFIELD, WEST VIRGINIA

PLATE XXIX

WALKER MOUNTAIN (SCHOOLEY ?), 3500 FEET IN ELEVATION, IN BACKGROUND. FROM HARRISBURG SURFACE OF APPALACHIAN VALLEY AT RURAL RETREAT, VIRGINIA

PLATE XXX

SKYLINE (SCHOOLEY ?), FORMED BY POWELL AND CLINCH MOUNTAINS, ABOUT 2100 FEET IN ELEVATION. LOOKING SOUTHEAST FROM PINNACLE AT CUMBERLAND GAP, KENTUCKY-VIRGINIA

PLATE XXXI

CUMBERLAND ESCARPMENT FROM CANOE CREEK VALLEY, THREE MILES SOUTH OF ASHVILLE, ALABAMA

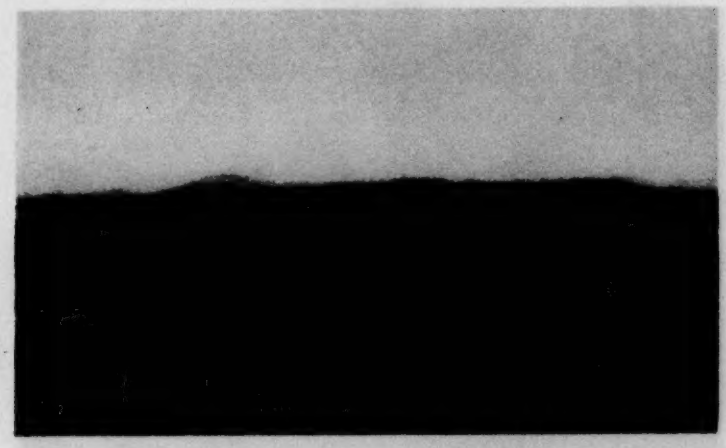

PLATE XXXII

BAYS MOUNTAIN, MONADNOCK ON THE HARRISBURG PENEPLANE, TWELVE MILES NORTHWEST OF GREENEVILLE, TENNESSEE

PLATE XXXIII

MISSIONARY RIDGE IN THE DISTANT MIDDLE GROUND, WHITE OAK MOUNTAIN IN THE FAR DISTANCE (MONADNOCKS ON THE HARRISBURG PENEPLANE), FROM EASTERN SLOPE OF LOOKOUT MOUNTAIN, JUST SOUTH OF CHATTANOOGA, TENNESSEE

PLATE XXXIV

CHERTY RESIDUAL COVER OF MISSIONARY RIDGE, CHATTANOOGA, TENNESSEE

PLATE XXXV

LINEAR MONADNOCK RIDGE IN APPALACHIAN VALLEY NEAR BLOUNTSVILLE, TENNESSEE

PLATE XXXVI

DISSECTED HARRISBURG SURFACE, NEAR WYTHEVILLE, VIRGINIA

PLATE XXXVII

HARRISBURG PENEPLANE WITH FOOTHILLS OF THE OLDER APPALACHIANS IN THE BACKGROUND, SOUTHWEST OF WYTHEVILLE, VIRGINIA

PLATE XXXVIII

HARRISBURG (?) SURFACE IN THE CLINCH RIVER VALLEY, BRISTOL, VIRGINIA-TENNESSEE, QUADRANGLE

PLATE XXXIX

VALLEY OF CLEAR FORK, TYPICAL INTERMONTANE VALLEY IN THE APPALACHIAN RIDGES. ABOUT TWENTY-FIVE MILES NORTH OF WYTHEVILLE, VIRGINIA

PLATE XL

ROLLING TOPOGRAPHY DEVELOPED ON THE HARRISBURG SURFACE IN THE APPALACHIAN VALLEY, NEAR CHILHOWIE, VIRGINIA

PLATE XLI

HARRISBURG PENEPLANE, FOUR MILES WEST OF JOHNSON CITY, TENNESSEE

PLATE XLII

DISSECTED HARRISBURG PENEPLANE UNDERLAIN BY SHALE, NEAR NEWPORT, TENNESSEE

PLATE XLIII

HARRISBURG PENEPLANE TWENTY-THREE MILES SOUTHWEST OF KNOXVILLE, TENNESSEE

PLATE XLIV

HARRISBURG PENEPLANE IN APPALACHIAN VALLEY WITH WALDEN RIDGE (SCHOOLEY) IN BACKGROUND, SEVERAL MILES SOUTH OF DAYTON, TENNESSEE

PLATE XLV

HARRISBURG PENEPLANE FROM WESTERN MARGIN OF PIEDMONT NEAR COLUMBIANA, ALABAMA

PLATE XLVI

MATURE VALLEY OF THE HOLSTON RIVER, SIX MILES NORTH OF KNOXVILLE, TENNESSEE

PLATE XLVII

LATE MATURE VALLEY OF THE TENNESSEE RIVER AT LOUDON, TENNESSEE

PLATE XLVIII

LATE MATURE VALLEY OF THE CONASAUGA RIVER, NORTH OF DALTON, GEORGIA

PLATE XLIX

NOCCALULA FALLS ON BLACK CREEK ON LOOKOUT MOUNTAIN, NEAR GADSDEN, ALABAMA

PLATE L

"COOSA" LOWLAND, FOUR MILES NORTHEAST OF CLEVELAND, TENNESSEE

PLATE LI

"COOSA" LOWLAND NEAR HEAD OF COAHULLA CREEK, SEVEN MILES SOUTHEAST OF CLEVELAND, TENNESSEE

PLATE LII

LOWLAND OF SOUTH CHICKAMAUGA CREEK, SIX MILES EAST OF CHATTANOOGA, TENNESSEE

PLATE LIII

VIEW IN CHICKAMAUGA PARK IN A LIMESTONE LOWLAND TWELVE MILES SOUTH OF CHATTANOOGA, TENNESSEE

PLATE LIV

COOSA LOWLAND FROM EAST SLOPE OF LOOKOUT MOUNTAIN, NEAR LEESBURG, ALABAMA

PLATE LV

JONES VALLEY LOWLAND, BESSEMER, ALABAMA

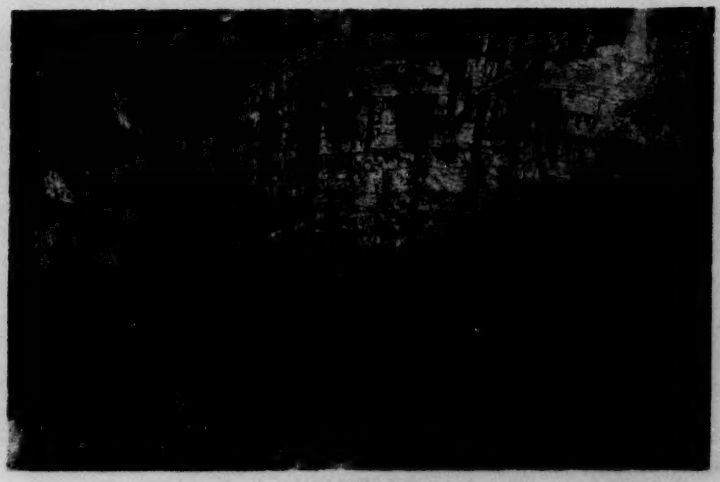

PLATE LVI

"THE CRATER," EXIT OF NATURAL TUNNEL, SCOTT COUNTY, VIRGINIA. TUNNEL MOUTH AT LOWER RIGHT HAND CORNER

PLATE LVII

LIMESTONE SINK TOPOGRAPHY, THREE MILES NORTH OF JONESBORO, TENNESSEE

PLATE LVIII

GORGE OF THE TENNESSEE RIVER IN WALDEN RIDGE WEST OF CHATTANOOGA, TENNESSEE, FROM SIGNAL HILL. (COURTESY CLINE STUDIOS, CHATTANOOGA, TENNESSEE)

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